JP4-171717

(19) Japanese Patent Office (JP)
(12) Laid-Open Disclosure Public Patent Bulletin
(11) Patent Application Laid-Open Disclosure No.: Hei 4-171717
(43) Publication Date: June 18, 1992
(51) Int. Cl.[5]

H01L	21/268	B	7738-4M
	21/20		9171-4M

Request for Examination: Not made
Number of Claims: 1 (11 Pages in Total)
(21) Patent Application No.: Hei 2-298165
(22) Patent Application Date: November 2, 1990

(71) Applicant: Sony Corp.
6-7-35, Kitashinagawa, Shinagawa-ku, Tokyo
(72) Inventor: Takashi NOGUCHI
6-7-35, Kitashinagawa, Shinagawa-ku, Tokyo
c/o Sony Corp.
(72) Inventor: Toshiharu SUZUKI
6-7-35, Kitashinagawa, Shinagawa-ku, Tokyo
c/o Sony Corp.
(74) Agent: Attorney Hidemori MATSUKUMA

Continued to the Last Page

Title of the Invention

Method for emitting laser light

Scope of Claim

A method for emitting with laser light,

wherein a semiconductor substrate and excimer laser light are rotated relatively in the method for emitting laser light for irradiating the semiconductor substrate with the excimer laser light.

Detailed Description of the Invention

[Industrial Field of the Invention]

The present invention relates to a method for emitting laser light, for example, in the case of carrying out a heat treatment on a semiconductor substrate, by irradiating the semiconductor substrate with excimer laser light.

[Summary of Invention]

In a method for emitting laser light for irradiating a semiconductor substrate with excimer laser light, the above semiconductor substrate and the above excimer laser light are rotated relatively according to the present invention; whereby an energy density distribution of laser light in a surface irradiated with laser light of the semiconductor base is made uniformly so that, for example, a heat treatment by excimer laser is uniformized easily.

[Prior Art]

Conventionally, there is a heat treatment on a wafer such as an electric furnace annealing; however, a variation between wafers is generated due to a batch processing system. Accordingly, it is a heat treatment by laser light that is developed as a heat treatment with a single wafer process system.

However, laser light itself has a very narrow irradiated region; therefore, it is arranged to irradiate the wafer with laser light in a spiral condition as shown, for example, in a Japanese Unexamined patent publication No. 55-150238 and a Japanese Unexamined patent publication No. 61-230318, when a heat treatment is carried out over the entire surface of the wafer.

Yet, the wafer surface besides a chip is to be irradiated in this case, thereby increasing temperature of the whole wafer; therefore, the wafer surface cannot be used for a heat treatment aimed at, for example, a shallow junction and the like of an impurity diffusion region.

Accordingly, it is a heat treatment by excimer laser light that is drawn attention here. The excimer laser light is ultraviolet region light and a pulsed laser that oscillates a short-wave length (-20nsec), and thus suitable for a heat treatment aimed at a heat treatment of a thin film silicon layer and a shallow junction of an impurity diffusion region.

[Problem to be Solved by the Invention]

However, the heat treatment by excimer laser light has a disadvantage that lacks uniformity within the surface of an energy density distribution with respect to a surface irradiated with a beam since the excimer laser light itself is a Gaussian beam.

Recently, an optical homogenizer is developed that molds an energy density distribution of excimer laser light into a surface distribution of a rectangular shape; therefore, uniformity within the surface of an energy density distribution with respect to a surface irradiated with a beam is becoming better.

Here, several systems are considered as the above optical homogenizer, and as a

typical example, the homogenizer is configured as shown in FIG. 10 by two lens body structures (42) that a plurality of spherical lenses (41) are provided at the incidence side of excimer laser light *l* are disposed respectively in a form that the sides of the spherical lenses (41) are placed outside, and furthermore, by placing a collimating lens (43) at the back of the above lens body structures (42). Accordingly, the focused laser light *l* by the lens body structures (42) is molded by the collimating lens (43) so that the laser light *l* can be obtained that has uniformity within a surface where an energy density distribution is uniform in a wide range.

However, when a lens system within the homogenizer is not vertical to an optical axis of incident beam *l*, but when there is an angular misalignment (inclination) for some angles and there is a mechanical position gap between a lens systems, a variation is made in an energy density distribution of the laser light *l* emitted from the homogenizer. Accordingly as shown in FIG. 11A, a so-called deviation is generated that an energy density distribution a will be, for example, uneven from side to side. Furthermore, also when dust, dirt, and the like are stuck on a lens system, there is a variation in the energy density distribution of the laser light that is emitted from the homogenizer (FIG. 11B is to be referred).

The above variation has a variation (error) of plus or minus within 5%, considering from the whole an energy density distribution; however, an annealing effect gets bigger in the part where energy density is large, and a heat treatment condition will be uneven within the surface irradiated with laser light. For example, each part of chip gets uneven at a heat treatment for each chip. In a case of a TFT by a silicon thin film manufactured in a heat treatment method so as to polycrystalize, for example, an amorphous film and the like for one by one with weak energy, a variation with a characteristic of such as leak current; mobility; and gate voltage is induced, and there is a variation in resistivity and a depth of junction when a shallow junction of an impurity diffusion region is formed.

In order to solve the variation of the above energy density distribution, a method for carrying out a heat treatment by scanning and overlapping the laser light emitted, for example, from the homogenizer can be considered. However, another problem arises that lose uniformity at a part where a surface irradiated with laser light is aligned, especially at the boundary part.

The present invention has been made in view of such a respect, and an object of the present invention is to provide a method for emitting laser light that can uniformize an energy density distribution in a surface irradiated with laser light, for example, that can easily enhance uniformity of a heat treatment by excimer laser light.

[Means for Solving the Problem]

A semiconductor substrate (4) and excimer laser light l_2 are rotated respectively in the method for emitting laser light of the present invention that irradiates the semiconductor substrate (sample (4)) with the excimer laser light l_2.

[Effect]

According to the above method of the present invention, it is arranged that the semiconductor substrate (4) is to be irradiated with the excimer laser light l_2, such that the semiconductor substrate (4) and the excimer laser light l_2 are rotated respectively. Accordingly, a variation is thrown away by the above rotation even though there is the variation at an energy density distribution of laser light l_2 that is emitted from a homogenizer (2). As a result, the energy density distribution within the surface irradiated with laser light is uniformed. Therefore, when, for example, a heat treatment is carried out on the semiconductor substrate (4) with the excimer laser light l_2, uniformity of the heat treatment on the semiconductor substrate (4) is improved, and a characteristic of a device formed on the semiconductor substrate (4) can be improved.

[Embodiment]

Embodiment of the present invention is described below with reference to FIG. 1 to FIG. 9.

FIG. 1 is a schematic diagram showing a method for emitting excimer laser light related to the present embodiment.

In the figure, (1) denotes excimer laser light source composed of, for example, XeCl and the like, and (2) denotes the homogenizer that the laser light l_1, of which an energy density distribution is a Gaussian mode, from the excimer laser light source is molded into the laser light l_2 which an energy density distribution is in a rectangular shape and has uniformity within the surface.

Furthermore, a thin film (hereinafter just referred to as the sample) (4) of a wafer or a quartz glass held in a susceptor (3) is irradiated with the laser light l_2 from the above homogenizer (2). Here, in the laser light l_1 emitted from the excimer laser light source (1), energy density distribution is about 150 mJ/cm^2, a pulse width is about 60 ns, and a pulse-number is about 100 Hz in a frequency conversion.

In such a manner, in the present embodiment, a rotation drive system (5) is connected to the susceptor (3). The sample (4) is irradiated with the laser light l_2 while rotating the susceptor (3) by the rotation drive system (5), and, for example, a heat treatment is carried out on the sample (4).

As mentioned above, according to the present embodiment, it is arranged that the sample (4) is to be irradiated with the laser light l_2 from the homogenizer (2) while rotating the susceptor (3) that holds the sample (4). Accordingly, although there is a variation in an

energy density distribution of laser light l_2 emitted from the homogenizer (2), the variation is thrown away by the rotation of the above sample (4), and as a result, the energy density distribution within the surface irradiated with the laser light l_2 on the sample (4) is uniformed. Therefore, a heat treatment by the laser light l_2 is uniformized, which can improve a characteristic of a device formed on the sample (4).

Furthermore, when the sample (4) is an amorphous silicon thin film for example, its polycrystalization can be made uniformly by carrying out a heat treatment by the above laser light l_2, thereby improving a characteristic of, for example, a thin film transistor (TFT) to a large extent that regards a thin film of a polycrystalline silicon formed by the heat treatment as an active layer.

In addition, when the sample (4) is a wafer, a heat treatment can be carried out uniformly on the wafer (4) since the wafer (4) can be irradiated with the laser light l_2 without making a variation, though the wafer (4) is curved or an optical axis of the laser light l_1 and l_2 is slightly declined.

Although dust and dirt are stuck on a laser transmitted surface (made of a quartz glass) within the homogenizer (2) or a chamber, the sample (4) can be irradiated with the laser light l_2 without generating a shade by the dust and the like; therefore, an influence by the above dust will not be a big problem in a heat treatment.

However, in order to ensure a light strength necessary for a heat treatment of excimer laser light, so-called a step and repeat system is taken notice that repeats a laser irradiation while sliding a wafer in the direction of X-Y by irradiating each chip with the laser light compared to irradiating a wafer with the laser light at a time.

As shown in FIG. 2, this is a system that irradiates each chip (6) by the homogenizer (2) with the laser light l_1 from the excimer laser source (1) by molding into the laser light l_2 with energy density that is even in a surface sized of the chip (6).

In a heat treatment by the step and repeat system, there is considerable mechanical difficulty in carrying out the treatment during a rotation of a stage.

Here, in the present embodiment, as shown in FIG. 3, a rotation drive system (7) is connected to the homogenizer (2), and each chip (6) on the sample (wafer) (4) is irradiated with the laser light l_2 while rotating the homogenizer (2) by the rotation drive system (7) without rotating a stage (not shown).

Specifically, it is constituted such that one chip (6) is irradiated with the pulsed laser light l_2 while rotating the homogenizer (2) with a rotating angle for several ten angles, and the homogenizer (2) makes one rotation with a pulsed irradiation of, for example, from 4 to 5 times.

Then, when the above plurality of pulsed irradiations of one chip (6) is finished, the

next chip (6) is irradiated with the pulsed laser light l_2 in the same way as above by sliding the stage or the homogenizer (2) in the direction of X or Y.

According to the present embodiment, a heat treatment by the laser light l_2 on one chip (6) is uniformized, and a characteristic and a reproducibility of each device on each chip are enhanced to improve; therefore, a high yield rate of the chips (6) can be realized. Furthermore, a cost for a good heat treatment by excimer laser light can be made cheap since a structure is also simple.

Whereas, recently, the lack in output of laser light is problematic in carrying out a heat treatment at a time by irradiating a unit of a chip with pulsed excimer laser light with a miniaturization of a pattern and a large area application of a chip in a semiconductor integrated circuit. Especially, an annealing on a large area is necessary for efficiency in carrying out a heat treatment on an active layer in a drive element for a liquid crystal display device (TFT), and in this case, it is further problematic in respect of the output.

Usually, a method for ensuring an incident energy of laser light can be considered, such that a substrate temperature is increased and an antireflection film is formed. However, the former method has disadvantage in a throughput or other limitation (in, for example, such as desiring to obtain a shallow junction of an impurity diffusion region). Furthermore, in the latter method, the formation of the antireflection film has a defect to generate contamination on a silicon surface, and, hence, not preferable.

Then, in the present embodiment, it is constituted such that energy dissipation by reflection in a silicon surface with excimer laser light is controlled, focusing that a reflectance of ultraviolet region light in a silicon surface runs from about 60 to 70%.

Specifically, as shown in FIG. 4, it is constituted such that a reflection mirror (9) is placed or that, as well as placing the sample (a) in a slant, laser light l_3 reflected in the sample surface (a) is returned to the sample (a) with a reflection mirror (10) placed additionally so that the laser light l_2 from the homogenizer (2) makes incident in a slant on the sample surface (for example, a silicon surface) (a). Note that, as a beam splitter is used instead of the reflection mirror (10), the laser light l_2 from the homogenizer (2) can be made incident vertically to the sample surface (a).

Now, incident energy of the laser light l_2 from the homogenizer (2) is given as E, and a reflectance of ultraviolet region light (including the laser light l_2) in the sample surface (a) is given as R (definite).

Then, energy E_1 taken in the sample surface (a) with the incident of the laser light l_2 for the first time can be obtained in the following equation.

$$E_1 = E\ (1-R) \qquad \text{---- (1)}$$

Next, the laser light l_3 reflected in the sample surface (a) is assumed to reflect 100%

in the reflection mirror (10), and energy E_2 that is taken in the sample surface (a) by making again the incident of the laser light l_3 reflected in the reflection mirror (10) in the sample surface (a) can be obtained in the following equation.

$$E_2 = ER\ (1-R) \qquad \text{----- (2)}$$

Therefore, a total energy E_p taken in the sample surface (a) with one pulsed irradiation will be like the following from the equations (1) and (2).

$$E_p = E_1 + E_2 = E\ (1-R^2) \qquad \text{----- (3)}$$

Here, when R is given as 0.7, E_p is 0.51 E from the equation (3) in the present embodiment. On the other hand, without the reflection mirror (10) as conventional, E_p is 0.3 E from $E_p = E_1$. Therefore, in the present embodiment, about 20% (0.2 E) of energy can be utilized effectively compared to the conventional technique.

Accordingly, energy efficiency with one pulsed irradiation is improved, and an annealing in a more large area is possible under a same laser device. As a result, as well as a large area application can be realized, a heat treatment on an active layer in a drive element for a liquid crystal display device can be carried out efficiently. Furthermore, as shown in FIG. 1 and FIG. 3, a heat treatment can be uniformized by rotating the homogenizer (2) or the sample (4) and by irradiating with the laser light l_2.

In a heat treatment of the above step and repeat system, an energy density distribution of the laser light l_2 is nearly uniformed by using the homogenizer (2), and a variation of energy between each pulsed irradiations is also improving (a variation of plus or minus 3% at present) with the improvement of the laser light source.

However, a problem is caused that a heat treatment on a silicon film or a depth of junction at an impurity diffusion region will not be uniform when there is a variation in a film thickness and a film quality of a base silicon film in the sample surface, or when there is a variation in a film thickness and a film quality of a cap film (including an antireflection function) such as SiO_2. In addition, a problem is also arising that a heat treatment will be insufficient since the laser output is deteriorated from some reason. Accordingly, a heat treatment by existing excimer laser light has a problem that cannot carry out a most suitable heat treatment when a condition for a heat treatment is changed by the elapse of the time.

Then, in the present embodiment, it is constituted that a reflectance reader is added that reads a reflectance within a surface irradiated with the laser light l_2 from the homogenizer (2) as shown in FIG. 5. In this case, it is desirable that the reflectance reader, as well as the homogenizer (2), has step feed on the sample (4). For example, it is constituted that He – Ne laser light source (11) of a continuous wave (CW) and a receiving optics (12) composed of a PIN diode and the like are provided at the both sides of the homogenizer (2) as shown in the drawing. Especially, in the present embodiment, the

above laser source (11) is disposed such that laser light l from the laser light source (11) makes incident within the surface irradiated with laser light where the sample (4) is irradiated with the laser light l_2 from the homogenizer (2), and furthermore, the laser light l is reflected in the above surface irradiated with the laser light, and the above receiving optics (12) is disposed such that a receiving surface of the receiving optics (12) will be at a passing position of the reflecting light l.

Then, a heat treatment is carried out on the sample (4) by irradiating the sample (4) with the pulsed laser light l_2. Hereat, a reflectance in the surface irradiated with the laser light on the sample (4) is definite as long as a condition for a heat treatment is definite, and a signal output S_{in} from the receiving optics (12) will be definite.

Temperature at the surface irradiated with the laser light on the sample (4) is increased by pulsed irradiation with the laser light l_2, and especially as a silicon film is melted, a refractive index is changed and a reflectance in at a silicon surface is increased. The reflectance change, in other words, output change of the reflection light l with the change of the reflectance is scanned at the receiving optics (12), converted into the electrical signal S_{in} according to the change, and given feedback to a laser output control circuit (13) connected to the excimer laser light source (1) with an amplifier and the like.

The laser output control circuit (13) corrects an output signal S_{out} based on the above electrical signal S_{in} from the receiving optics (12) and the output signal S_{out} is provided to an oscillation output system of the laser light source (1). Then, the laser light l_1 with energy corresponded to the above output signal S_{out} is outputted from the laser light source (1), and the sample (4) is irradiated with the laser light l_1 as the laser light l_2 that the energy density is uniformed within the surface with the homogenizer (2). Thus, the reflectance of the surface irradiated with the laser light on the sample (4) is held in constant.

According to the present embodiment, a heat treatment can be carried out while holding the reflectance of the surface irradiated with the laser light in constant, in other words, holding a condition of a heat treatment in constant, whereby excimer laser annealing by a step and repeat system can be uniformized without being influenced by a change of a base film (a change of a film thickness and a film quality).

Now, in the excimer laser annealing by the existing homogenizer, a heat treatment can be carried out on an area up to about 15 mm × 15 mm with pulsed irradiation in uniformity of plus or minus within 5%.

However, an area of one chip in the high integrated circuit such as SRAM is about 8 mm × 14 mm at 4 Mbit SRAM and about 20 mm × 11 mm at 16 Mbit SRAM; therefore, a region is formed that is not irradiated in a pulse oscillation when a process is carried out with one pulsed irradiation on one chip. In a chip with a small area, the above problem

can be solved by a device such as making a surface irradiated with laser light into a rectangular shape; however, it is necessary to process one chip with pulsed irradiation in a plurality of times (by the way, an irradiated area is determined by producing technology of a homogenizer, and energy density above a certain level is necessary for a process; therefore, by a total output).

The following problem is cased when one chip is processed with a plurality of pulsed irradiations.

Taking 16 Mbit SRAM as an example here, one chip (21) is usually in a rectangular pattern of 20 mm in width and 11 mm in length as shown in FIG. 6; therefore, the process with a plurality of pulsed irradiations must be divided into 3 when the chip (21) is irradiated regarding a decoder wiring (22) as a boundary and considering an alignment accuracy. However, when a shape of an irradiated area is set at a region of a central part shape and continuously irradiated in a constant, spaces d between the chips (21) are about 1 mm. Therefore, right-and-left regions (21*l*) and (21*r*) to the chip (21) are irradiated with laser light resulting in that the right-and-left regions (21*l*) and (21*r*) of the chip (21) adjoined are irradiated simultaneously. As a result, the right-and-left regions (21*l*) and (21*r*), especially the shaded regions are irradiated respectively in a pulse oscillation over two times; thereby bringing a heat treatment that is carried out nonuniformly.

Thus, in the present embodiment, as shown in FIG. 7, it is constituted such that an irradiated region variable mechanism (23) is disposed between the homogenizer (2) and the sample (4), and that a rectangular irradiated region (24) with the laser light l_2 from the homogenizer (2) will be variable.

The irradiated region variable mechanism (23) is composed of two windows (26*a*) and (26*b*) which at least face each other on a window tray (25) connected to the homogenizer (2), and the two windows (26*a*) and (26*b*) is slid (opened and closed) so that the above region irradiated with laser light (24) is made variable.

For example, an opening and closing means by a known solenoid mechanism can be used to open and close the windows (26*a*) and (26*b*). For example, in an initial condition, an aperture width m of an aperture (27) that is held in the direction of "opening" with each other by, for example, each of tension spring and formed by each of windows (26*a*) and (26*b*) is set at, for example, about 10 mm in each of windows (26*a*) and (26*b*).

Then, in a first window drive system (28*a*) that incorporated the above solenoid mechanism, the window (26*a*) is pressed so that the window (26*a*) is slid to the other side of the window (26*b*), and a given position, for example, a position that covers a half of the right-hand side of the aperture (27) in the initial condition (fully open condition) of the above is fixed by, for example, a stopper that is not shown. On the other hand, in a second

window drive system (28*b*), the other window (26*b*) is pressed so that the window (26*b*) is slid to the side of the window (26*a*), and a given position, for example, a position that covers a half of the left-hand side of the aperture (27) in the initial condition of the above is fixed by a stopper likewise.

Of course the above switching means is just an example, and various sorts of opening and closing means can be used. The present embodiment is described expediently along the above means and described below over the operation also with reference to FIG. 8 and FIG. 9. Here, it is regarded that the homogenizer (2) is placed especially at a right-hand side (1st position) P_1 shown in FIG. 9A on the one of chips (21) on the sample (wafer) (4).

First, based on an input of a set pulse (a completion signal from a X-Y drive system (32) that slides a stage (not shown)) ps into a controller (31), the first window drive system (28*a*) from the controller (31) is provided with a drive signal S_1. Based on the input of the above drive signal S_1, the first window drive system (28*a*) presses the window (26*a*), and the aperture (27) by the window (26*a*) and (26*b*) is made into a condition that is partly open (right-hand side covered). Thereafter, after a given time of t_1 is passed since the above set pulse ps has been inputted, the controller (31) outputs a drive signal Sl at the excimer laser light source (1). Based on the input of the drive signal Sl, the excimer laser light source (1) irradiates with the pulsed excimer laser light l_1 as the laser light l_2 interposing the homogenizer (2). In such a case, a region irradiated with laser light (W) in the 1st position is restricted to the half of the left-hand side by the window (26*a*); therefore, only a half of the left-hand side of the above region (W) is irradiated with the laser light l_2 from the homogenizer (2).

Next, after a given time of t_2 is passed since the raise of the above drive signal Sl, the X-Y drive system (32) is provided with a drive signal St (St_1) from the controller (31) so that the stage is slid, for example, in the x direction. Hereat, the above drive signal P_1 [sic] is decayed so that one window (26*a*) is recovered to the initial condition; therefore, the aperture (27) by the windows (26*a*) and (26*b*) will be in a fully open condition. On the other hand, the drive signal St_1 has relatively a long pulse width since it has necessity to slide the stage in the x direction of the homogenizer (2) for a distance b/2, that is, about a half of a wide length b of the chip (21). The homogenizer (2) is placed on a center (2nd position) P_2 of the chip (21) by sliding the stage based on the drive signal St_1. Then, the controller (31) is provided with the completion signal as the set pulse ps from the X-Y drive system (32) as well as the slide of the stage is finished. The controller (31) outputs the drive signal Sl at the laser light source (1) after the given time of t_1 is passed since the set pulse ps has been inputted. As mentioned above, based on the input of the drive signal Sl, the laser light source (1) emits the pulsed excimer laser light l_1. In such a case, the

aperture (27) by the window (26*a*) and (26*b*) is fully opened; therefore, a whole region irradiated with laser light (W) is irradiated with the laser light l_2 from the homogenizer (2).

Next, after a given time of t_2 is passed since the raise of the above drive signal S*l*, the X-Y drive system (32) is provided with a drive signal S*t* (St_2) from the controller (31) so that the stage is slid further in the x direction. As mentioned above, the drive signal St_2 has relatively a long pulse width corresponding to sliding the stage in the x direction of the homogenizer (2) for a distance about b/2 as above. The homogenizer (2) is placed on a left-hand side (3rd position) P_3 of the chip (21) by sliding the stage based on the drive signal St_2. Then, the controller (31) is provided with the completion signal as the set pulse ps from the X-Y drive system (32) as the slide of the stage is finished.

Based on the input of the above set pulse ps, the controller (31) provides the second window drive system (28*b*) with a drive system S_2 in turn. Based on the input of the drive system S_2, the second window drive system (28*b*) presses the other window (26*b*), and the aperture (27) by the windows (26*a*) and (26*b*) is made into a condition that is partly open (left-hand side closed). Thereafter, after a given time of t_1 is passed since the above set pulse ps has been inputted, the controller (31) outputs a drive signal S*l* at the excimer laser light source (1). Based on the input of the drive signal S*l*, the excimer laser light source (1) irradiates with the pulsed excimer laser light l_1. In such a case, the region irradiated with laser light (W) in the 3rd position P_3 is restricted to the half of the right-hand side by the other window (26*b*); therefore, only a half of the right-hand side of the above region (W) is irradiated with the laser light l_2 from the homogenizer (2).

Next, after a given time of t_2 is passed since the raise of the above drive signal S*l*, the X-Y drive system (32) is provided with a drive signal S*t* (St_3) from the controller (31) so that the stage is slid a little in the x direction. Hereat, the above drive signal S_2 is decayed so that the other window (26*b*) is recovered to the initial condition; therefore, the aperture (27) by the windows (26*a*) and (26*b*) will be in a fully open condition. On the other hand, the drive signal St_3 may only to slide the stage in the x direction of the homogenizer (2) for a distance corresponding to the spaces d between the chips (21); therefore, its pulse width is made smaller than that of the above drive signals St_1 and St_2. As shown in FIG. 9B, the homogenizer (2) is placed at the right-hand side (1st position) P_1 of the next chip (21) by sliding the stage based on the drive signal St_3. The rest is to carry out excimer laser annealing with a step and repeat system on all chips (21) on the wafer (4) by repeating a set of the operation mentioned above.

According to the present embodiment, the chip (21) with a broad area like the 16 Mbit SRAM is irradiated with the laser light l_2 from the homogenizer (2) completely, without being added unnecessarily, and evenly; therefore, a heat treatment by excimer laser

light is uniformized. Furthermore, the uniformity can be made efficiently by using the both methods shown in FIG. 1 and FIG. 3 at the same time.

In addition, according to the above embodiment, the wafer (4) can be irradiated such as so-called brief note writing; therefore, a throughput will not be decreased.

[Effect of the Invention]

According to the method for emitting laser light related to the present invention, an energy density distribution in the surface irradiated with laser light can be uniformized, and for example, a heat treatment by excimer laser light can be uniformized easily.

Brief Description of the Drawings

Figure 1 is a schematic diagram showing a method for emitting laser light related to the present invention.

Figure 2 is an explanatory view showing a step and repeat system.

Figure 3 is a schematic diagram showing other methods of the present embodiment.

Figure 4 is a schematic diagram showing a method of a heat treatment using a reflected mirror.

Figure 5 is a schematic diagram showing a method of a heat treatment by a feed back system of the present embodiment.

Figure 6 is an explanatory view showing a negative effect by pulsed irradiation of usual for a number of times.

Figure 7 is a schematic diagram showing a method of pulsed irradiation for a number of times of the present embodiment.

Figure 8 is a waveform chart showing a signal treatment.

Figures 9 are an explanatory view showing an order of pulsed irradiation of the present embodiment.

Figure 10 is a view showing a configuration of an example of a homogenizer.

Figures 11 are an explanatory view showing an example of variation in energy density distribution.

(1) is an excimer laser light source, (2) is a homogenizer, (4) is a sample, and (5) and (7) are rotation drive systems.

Description of the marks

1 --- excimer laser light source

2 --- homogenizer

3 --- susceptor

4 --- semiconductor substrate

5 --- rotation drive system

6 --- chip

7 --- rotation drive system
9 --- reflection mirror
10 --- reflection mirror
11 --- $H_c - N_e$ laser light source
12 --- receiving optics
13 --- laser output control circuit
21 --- chip
21*l*, 21 r --- right-and-left regions to the chip (21)
22 --- decoder wiring
23 --- irradiated region variable mechanism
24 --- irradiated region
25 --- window tray
26*a*, 26*b* --- window
27 --- aperture
28*a* --- first window drive system
28*b* --- second window drive system
31 --- controller
32 --- X-Y drive system
41 --- spherical lens
42 --- lens body structure
43 --- collimating lens
a --- energy density distribution
a --- sample surface
d --- spaces between the chips (21)
l_1, l_2, l_3 --- laser light
l --- laser light
m --- aperture width
ps --- set pulse
P_1 --- 1st position
P_2 --- 2nd position
P_3 --- 3rd position
S_1, S_2 --- drive signal
St (St_1, St_2, St_3) --- drive signal
Sl --- drive signal
S_{in} --- signal output
S_{out} --- output signal

t_1 --- given time since the input of the set pulse ps
t_1 --- given time since the raise of the drive signal S*l*